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(11) Publication number:

0 400 424
A1

(2)

EUROPEAN PATENT APPLICATION

(21) Application number: 90109510.9

(51) Int. Cl. 5: E04C 2/32

(22) Date of filing: 18.05.90

(23) Priority: 01.06.89 US 359540

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(43) Date of publication of application:
05.12.90 Bulletin 90/49

(24) Designated Contracting States:
BE CH ES FR GB IT LI

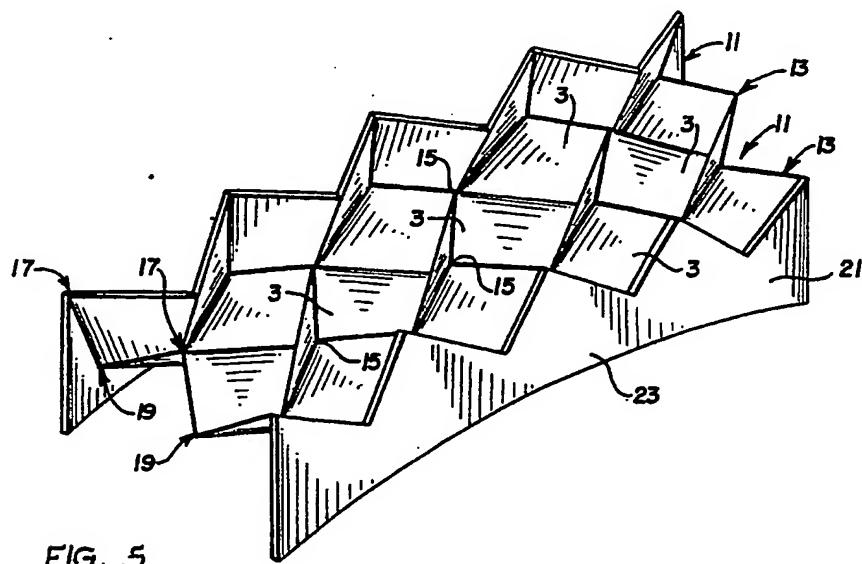
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(54) Biaxially corrugated flexible sheet material.

(57) A flexible biaxially corrugated sheet material (1) is formed from a plurality of identical trapezium segments (3) which are arranged in a plurality of long strips (9) a single segment wide. Adjacent strips (9) are mirror images of each other and connected along adjoining sides with the angles of the four

corners of adjacent segments being alternately less than 360° and greater than 360° along the length of a strip such that the sheet material has an undulating configuration, and is inherently curved and cannot lie in a flat plane.



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This invention relates to a biaxially corrugated flexible sheet material, and, more particularly, to such a sheet material that is formed of a plurality of trapezium segments.

Several types of sheet material are currently used to form items such as seals, bellows, and the like. These materials are typically corrugated along one axis in order to give the structure strength and flexibility. The materials must be curved, such as when used in a cylinder, and be expandable. Currently such materials are generally flexible in only one direction, so that when the material is pulled axially, the diameter of the structure into which the material has been formed decreases slightly.

One type of corrugated sheet material is disclosed in U.S. Patent No. 3,992,162. That sheet material is described for use as a building material, thus, it is not particularly necessary that the sheet material be flexible. The herringbone corrugation pattern described therein is formed from a plurality of abutting elementary surfaces, the sides of which are contiguous and the corners of which meet at points, which when the material is corrugated, form peaks and valleys. The sum of the angles of the corners of the elementary surfaces at each point is 360° so that the sheet material can lie in a flat plane, but cannot follow an initially curved surface.

An object of the invention is to develop a flexible sheet material that is flexible in the direction of its length and width, so that it can expand in both directions at once. Further, it is desired to develop such a material wherein the flat planes of the segments of the sheet material fit together to form an initially curved shape.

Summary of the Invention

The present invention resides in a flexible biaxially corrugated sheet material formed from a plurality of identical trapezium segments. Each trapezium segment has four edges and four corners formed at the juncture of the edges. Two edges meet at an angle to form each corner.

The trapezium segments are arranged in a plurality of elongated strips. Each strip is a single trapezium segment wide and has first and second opposed sides formed by the free edges of the trapezium segments in the strip. Adjacent strips are mirror images of each other and are connected to each other along their adjoining sides so that the edges of adjacent trapezium segments meet and four corners of four adjacent trapezium segments meet at a point. The sum of the angles of the four corners at each point are alternately less than 360° and greater than 360° along the length of the adjacent strips.

The sheet material has an undulating configuration of alternating ridges and valleys, is inherently curved, and cannot lie in a flat plane.

5 The sheet material is flexible in two directions and has improved flexibility in the axial direction than other currently available types of corrugation patterns.

10 Figure 1 is a plan view of three adjacent elongated strips of trapezium segments used to form the sheet material of the invention;

15 Figure 2 is a plan view of the three adjacent elongated strips of trapezium segments of Figure 1 shown connected together;

20 Figure 3 is an elevational view of a sheet material formed of the elongated strips of Figure 1;

25 Figure 4 is an isometric view of the sheet material of the invention illustrating it in an initially curved cylindrical configuration with transition members used to attach the sheet material to a curved surface; and

Figure 5 is a perspective view of the sheet material of the present invention illustrating the alternating peaks and valleys and the transition members.

Detailed Description of the Preferred Embodiments

30 The flexible sheet material 1 of the present invention is formed of a plurality of identical trapezium segments 3. The trapezium segments 3 are quadrilaterals which do not have any parallel edges. Each of the trapezium segments 3 have four edges 5, specifically labeled 5a, 5b, 5c and 5d, and four corners 7, specifically labeled 7a, 7b, 7c and 7d, formed at the juncture of the edges 5 so that the edges 5 extend between the corners 7. Two contiguous edges 5 meet at an angle, specifically A, B, C and D, to form each corner 7. As shown in Figures 1 and 2, edges 5a and 5b meet at an angle A to form the corner 7a, edges 5b and 5c meet at an angle B to form the corner 7b, edges 5c and 5d meet at an angle C to form the corner 7c, and edges 5d and 5a meet at an angle D to form the corner 7d. None of the edges 5 can be parallel to another edge 5 in a trapezium segment 3, and the length of the edges 5a, 5b, 5c and 5d cannot all be the same, nor can the length of the opposed edges 5a and 5c be equal at the same time that the length of the opposed edges 5b and 5d are equal. Similarly, the angles A, B, C and D cannot all be the same, nor can the sum of the angles A and B be 180° at the same time that the sum of the angles C and D is 180°. The length of the edges 5 and size of the angles can all be different.

40 45 50 55 The trapezium segments 3 are arranged in a plurality of elongated strips 9, illustrated as three

strips 9', 9" and 9'" in the figures. Each strip 9 is a single trapezium segment 3 wide and has first and second opposed sides 11 and 13, respectively, formed by the free edges 5b and 5d of the trapezium segments 3 in the strip 9, as shown in Figure 1 and 2. As illustrated in the figures, each trapezium segment 3 in a strip 9 is connected to adjacent trapezium segments, with three such strips 9, designated 9', 9" and 9'", along opposed edges 5 of the trapezium segment 3, rather than contiguous edges 5. While the trapezium segments 3', 3" and 3'" are labeled differently, they are identical. Trapezium segments 3' and 3'" are oriented at 180° with respect to the trapezium segment 3'. As shown in Figures 1 and 2, the edge 5a' of a trapezium segment 3' in a strip 9' is connected to the edge 5a" of one of the adjoining trapezium segments 3" and the edge 5c' of the trapezium segment 3' is connected to the edge 5c" of the other of the adjoining trapezium segments 3".

As shown in Figures 1 and 2, strip 9' is a mirror image of adjacent strips 9" and 9'". The strips 9', 9" and 9'" are connected to each other along their adjoining sides 11', 11" and 13', 13'" respectively, so that the edges 5 of adjacent trapezium segments 3 meet and four corners 7 of four adjacent trapezium segments 3 meet at a point 15. While the strips 9" and 9'" are labeled differently, they are identical and are mirror images of the strip 9'.

It is critical to the present invention that the sum of the angles of the four corners 7 at each point 15 are alternately less than 360° and greater than 360° along the length of adjacent strips 9. As shown in Figure 1, alternately the sums of the angles are the sum of angles A, A, D, and D, and the sum of the angles B, B, C and C. Typically, the sum of the angles of the four corners 7 is alternately between about 300° and about 320° and between about 420° and about 400° along the length of the adjacent strips 9. The sheet material 1 has an undulating configuration of alternating ridges 17 and valleys 19 to provide flexibility along both its length and its width, as shown in Figures 2 to 5.

The sheet material 1 is inherently curved and cannot lie in a flat plane. Thus, the sheet material can be formed into a variety of curved configurations, such as a cylinder, saddle, and sphere, depending upon the intended use of the sheet material 1. Since the sheet material is in a curved configuration and has an undulating configuration of alternating ridge and valley, transition elements 21 are provided which have a curved end surface 23 to enable securement thereto to a surface of a substrate to which the sheet material is to be fixed. While only two such transition elements 21 are illustrated in the drawings in parallel relationship, two other such transitional elements may be pro-

vided in the transverse direction to provide a transition element boundary for the sheet material.

5 The sheet material 1 is versatile and can be used to provide structural flexibility for seals, such as pressure activated seals, bellows, such as blow molded bellows, actuators, protective bellows type covers, peristaltic pumps, fillers and the like. If made of fabric, the sheet material 1 can also be used to fit the same piece of clothing, such as a sweater, to people of different sizes.

10 The sheet material 1 can be formed of various flexible materials such as plastic, metal, fabric, felt, papers and other cellulosic materials, rubber, cloth fabric, and the like, depending on the intended use of the sheet material 1.

Claims

20 1. A biaxially flexible corrugated sheet material (1) characterized in that it consists of: a plurality of identical trapezium segments (3), and that said trapezium segments are arranged in a plurality of elongated strips (9), each of said strips being a single trapezium segment wide and having first and second opposed sides (11, 13) formed by the free edges (5) of said trapezium segments in said strip; that the adjacent ones of said strips are mirror images of each other and are connected to each other along their adjoining sides so that the edges of adjacent said trapezium segments meet and four corners (7) of four adjacent trapezium segments meet at a point, the sum of the angles (A, B, C, D) of said four corners at each said point being alternately less than 360° and greater than 360° along the length of said adjacent strips; and that said sheet material has an undulating configuration of alternating ridges (17) and valleys (19) and cannot lie in a flat plane.

25 2. The corrugated sheet material of claim 1, characterized in that said edges (5) of said sheet material include a transition layer (21) having a curved end surface.

30 3. The corrugated sheet material of claim 1 or 2, characterized in that the sum of the angles (A, B, C, D) of said four corners (7) at each said point is alternately between about 300° and about 320° and between about 420° and about 400° along the length of said adjacent strips.

35 4. The corrugated sheet material of any of claims 1 to 3, characterized in that it is formed of a material selected from the group consisting of plastic, metal, fabric, felt, paper and other cellulosic materials, cloth, and rubber.

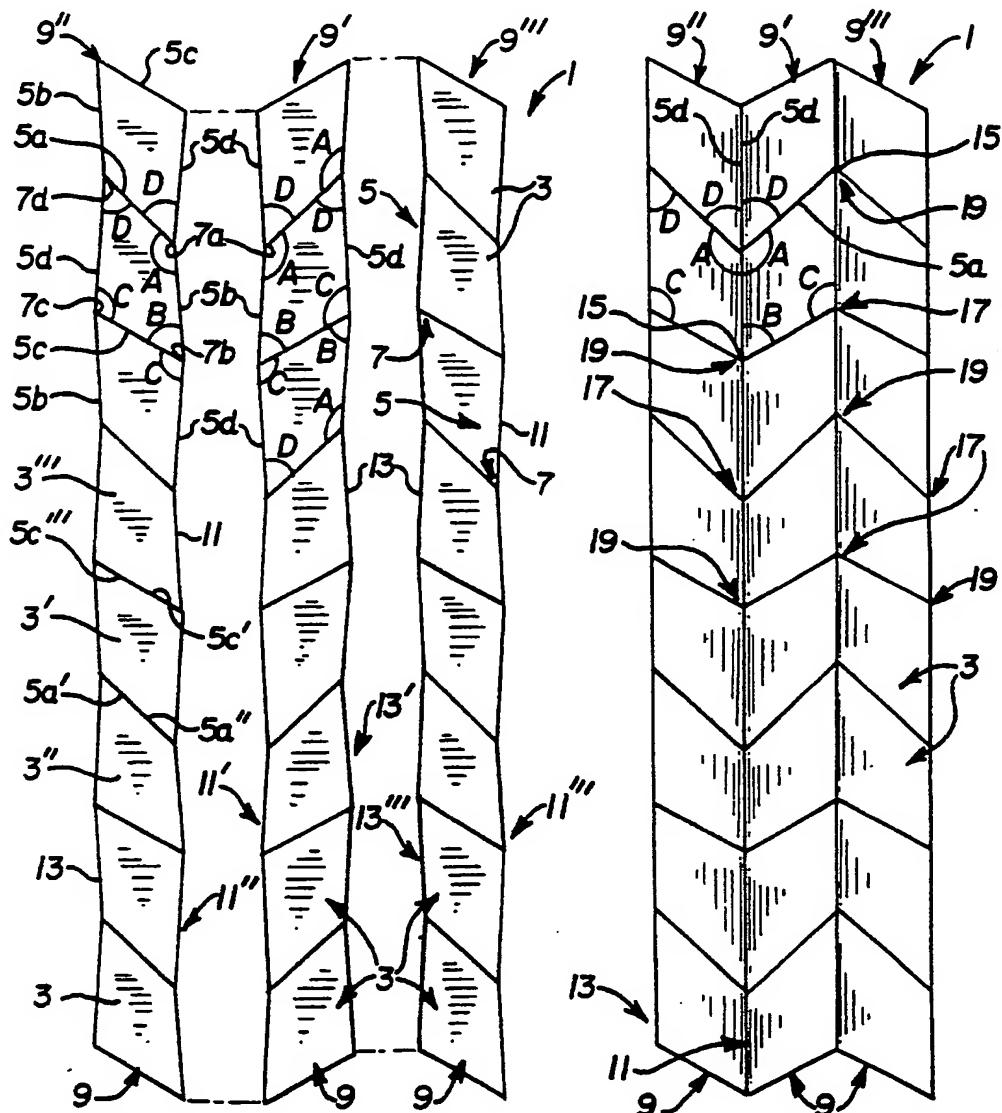


FIG. 1

FIG. 2

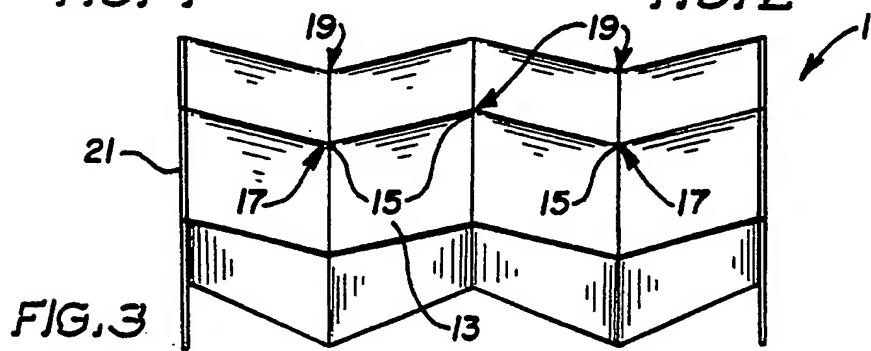


FIG. 3

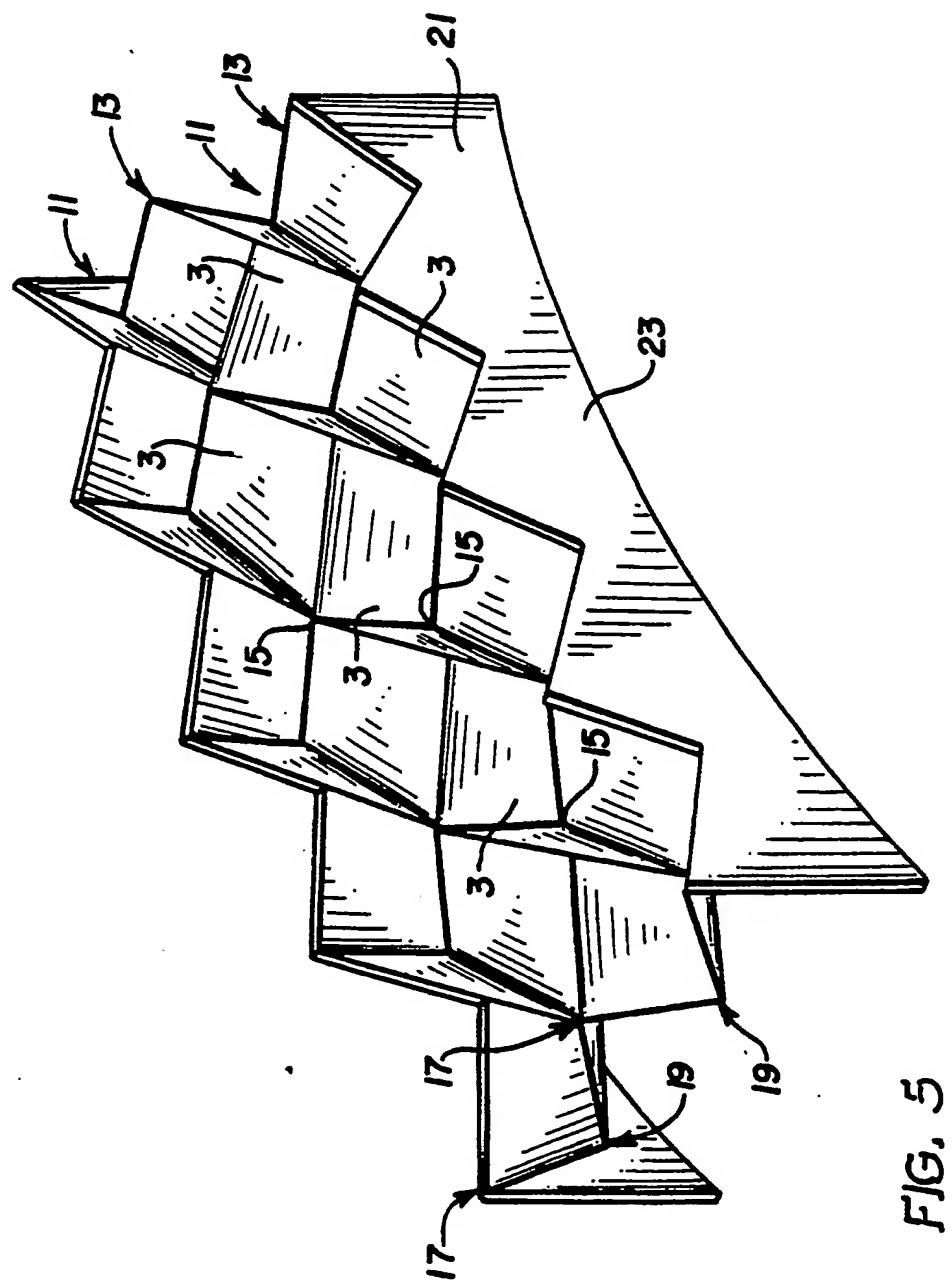


FIG. 5

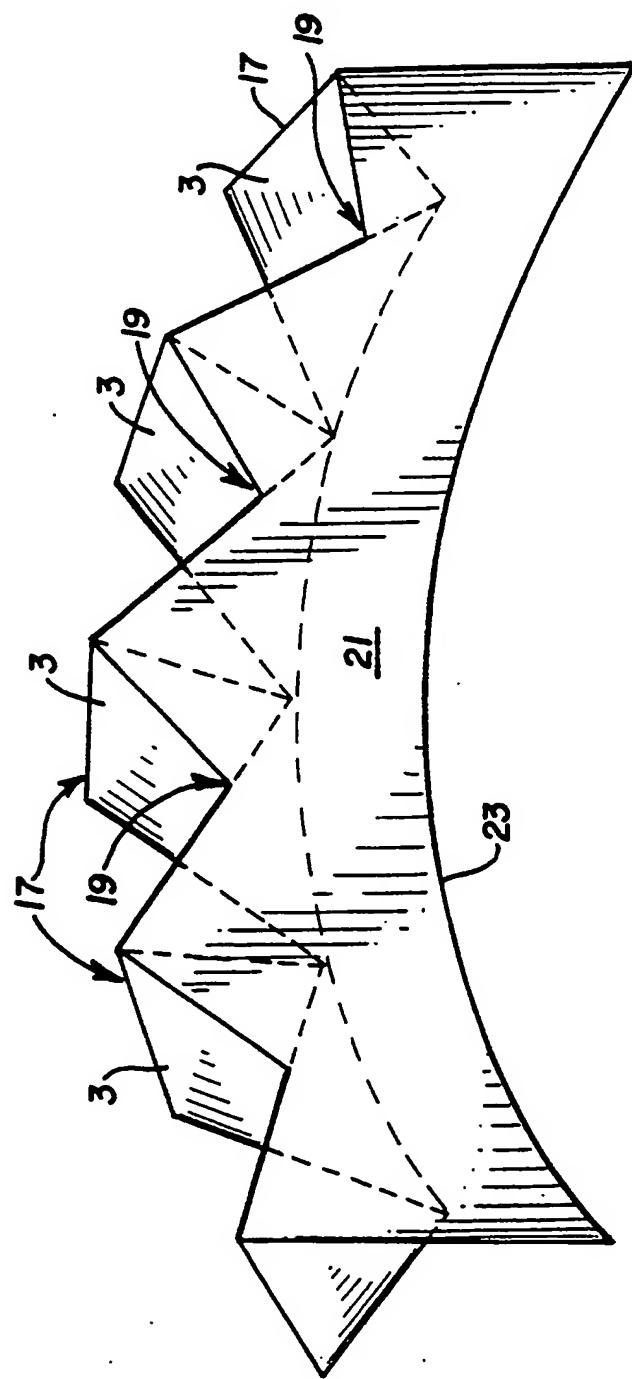


FIG. 4



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EUROPEAN SEARCH REPORT

Application Number

EP 90 10 9510

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. CL.5)						
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim							
A	GB-A-2 123 874 (BARNVALE PTY) * Figures 3,4 * -----	1	E 04 C 2/32						
			TECHNICAL FIELDS SEARCHED (Int. CL.5)						
			E 04 C F 16 J F 16 L						
<p>The present search report has been drawn up for all claims</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">Place of search</td> <td style="width: 33%;">Date of completion of the search</td> <td style="width: 34%;">Examiner</td> </tr> <tr> <td>THE HAGUE</td> <td>31-07-1990</td> <td>MYSLIWETZ W.P.</td> </tr> </table> <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>				Place of search	Date of completion of the search	Examiner	THE HAGUE	31-07-1990	MYSLIWETZ W.P.
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